VARIATIONS IN THE GLENOID FOSSAE[1]

By LOUIS R. SULLIVAN

THE glenoid fossae are depressions in the base of the squamous portion of the temporal bones just posterior to the roots of the zygomae. They are usually described as being deep.

W. L. H. Duckworth[2] in his description of the crania of aboriginal Australians remarks on the extremely flattened and shallow glenoid fossae and submits that this is an approach to a state that is usual in anthropoid apes. In a later work[3] he lists this condition as a characteristic of both Australians and Tasmanians.

In 1915 Mr. F. H. S. Knowles published a paper on the "Glenoid Fossa in the Skull of the Eskimo"[4] in which he represents the Eskimo as "the champions of the shallow glenoid fossae." He explains this shallow condition by the tough nature of their food and the great development of the lower jaw and masticatory muscles. His observations were on Eskimo crania from Smith Sound.

In the July–September number of the *American Anthropologist*, 1916, Mr. Hawkes and Mr. Wallis confirmed Mr. Knowles' observations to a certain extent, but pointed out that there was considerable variation even among the Eskimo.

The important question raised by these papers is the cause of this structural variation. Is it a racial characteristic linking those individuals or races which possess it to the apes or is it a caenotelic character recently acquired by the race or by the individual as an adaptation to environment, food habits, and methods of mastication?

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[1] Preliminary report read before American Anthropological Association, New York, 1916.

[2] *Studies in Anthropology*, p. 107.

[3] *Morphology and Anthropology.*

[4] *Anthropological Series*, No. 4, *Museum Bulletin*, No. 9, *Canadian Geological Survey.*

My observations on the collection of skulls in the American Museum of Natural History agree in the main with those already mentioned. There are a few points I would like to add to and one or two new observations.

I believe I am safe in making the following general assumptions. If this shallow glenoid fossa is a racial characteristic it should be relatively constant especially in such a comparatively pure race as the Eskimo. If it is of functional origin we should expect it to be extremely variable.

Mr. Knowles does not state the number of skulls in the series on which he based his conclusion. In a series of twenty-seven Eskimo skulls from Point Barrow, Alaska, Mr. Hawkes and Mr. Wallis found twelve shallow, twelve medium, and three deep. By "shallow" we mean that the articular surface has apparently moved forward so that the greatest pressure is brought to bear on the root of the zygomae or anterior articular eminence which also increases the antero-posterior diameters of the fossae. I have separated the shallow from the extremely flattened and get the following results:

No. in Series	*Region*	*Deep and Short*	*Medium and Short*	*Shallow and Elongated*	*Flat and Elongated*
15	Isle of St. Lawrence, Alaska	0	5	6	4
33	Indian Point, Siberia	7	6	13	7
50	Point Barrow, Alaska	10	5	14	21
19	Ponds Inlet	9	2	1	7
5	Smith Sound	1	0	3	1
122		27	18	37	40
	Approximate percents.	21	15	31	33

These figures would tend to diminish the value of the glenoid fossa as a racial characteristic if we consider the Eskimo as a unit. The results do not detract from Mr. Knowles's explanation of the cause.

I would also like to call attention to the fact that shallow glenoid fossae occur in other races with a similar frequency. The results in the accompanying table are largely from American Indians.

Smaller series of four or five crania from other parts of the United States, Solomon Islands, Australia, American Negroes, gave

similar results. According to Mr. Duckworth it must be of frequent occurrence in Australians and Tasmanians. Giuffrida-Ruggeri[1] finds this characteristic in Italian crania. Mr. Hawkes

No. in Series	*Region*	*Deep and Short*	*Medium and Short*	*Shallow and Elongated*	*Flat and Elongated*
86	Utah, Grand Gulch	16	32	28	10
4	Arizona	1	1	1	1
8	Colorado	1	2	4	1
10	New Mexico, Zuni	2	1	0	7
91	Mexico, Valley of Mexico City	22	22	18	29
12	Mexico, Valley of Mexico City (trepanned)	2	6	3	1
19	Mexico, Chihuahua	6	6	6	1
17	Mexico, Cora	3	3	7	4
56	Huichol	5	15	15	21
92	Tarasco	17	41	19	15
54	Peru (mountains)	0	26	17	11
150	Bolivia, Huata (Deformed)	42	38	50	20
268	Bolivia, Sicasica (Deformed)	91	37	86	54
11	Patagonia	0	0	10	1
14	Bedouin	7	4	3	0
26	Samaritan	8	7	9	2

in unpublished data has shown considerable variation even in the apes. All of which would seem to indicate that it is a widely distributed structure.

I should indicate that my determination of the depth of the fossae was based on arbitrary judgment. This method was adopted after a careful consideration of the method proposed by Mr. Knowles, the results of which do not seem to justify the labor. I was also influenced by the assumption that my error would be diminished by the examination of larger series.

So far I have considered the fossae to be identical on the left and right sides. But in all series examined I noted a marked asymmetry of the fossae not only in different skulls of the same race but also on the left and right sides of the same skull.

With this asymmetry of the fossae goes an unequal wear of the teeth, the teeth on the side of the more shallow fossae being worn more than those on the opposite side. In many cases where an asymmetry of the fossae was found it was impossible to make the comparison on account of the loss of teeth. In the few cases where

[1] *Science*, N. S., vol. XLIII, 1916, pp. 904.

the teeth were present in both upper and lower jaw the wear justified the conclusion that the difference in the shallowness of the sides was due to a greater use of that side which was most shallow. In some cases I also found an asymmetry in the form of the condylar process of the mandible.

Of the ten Eskimo skulls from St. Lawrence Island examined for this characteristic I found four which showed asymmetry; twenty skulls from Indian Point, Siberia, showed five asymmetrical; twenty-eight Peruvian showed eight asymmetrical. I also found marked examples in smaller series from Zuñi, New Mexico; Sicasica, Patagonia, Australia, Solomon Islands, in the crania of Indians from New York and Tennessee, and in those of American-African Negroes. I believe this is strong evidence for the functional modification of the fossae. It also indicates that individual habits of mastication influence the form of the articular surface.

The embryology, structure, and movements of the joint should also be emphasized. They are decidedly in favor of a functional modification. At birth in man and apes at least, and as far as I have observed in other mammals, the fossa is shallow or flat. In man it remains flat until about the age of three.[1] The region anterior to the Glasserian fissure is extremely thin. Even in the adult it will transmit light in some cases. It seems reasonable to believe that such a structure would be depressed by pressure. In accounting for the shallow fossa the point is that the greatest pressure is not brought to bear on this region, but is distributed over a larger area, chiefly anterior to the typical position of the glenoid fossa.

This is a double joint.[2] It is divided into two parts by an inter-articular disc of fibro-cartilage. The hinge-like movements of the lower jaw take place between the jaw and this cartilaginous disc. The external pterygoid muscle is attached in part to the disc and consequently the disc and the condyle of the lower jaw move together on the articular surface of the temporal bone in gliding and rotatory movements.

[1] *Human Anatomy*, Piersol.

[2] *Human Anatomy*, Gray.

The cartilaginous disc helps to break the force of sudden shocks, but I believe in the gliding movement considerable pressure is brought to bear on the articular eminence. The disc is very thin near its center and shows the probable effect of wear by being frequently perforated.

Finally, I believe we are justified in concluding that the variations in the glenoid fossae are due to function. That the rotary, and fore and aft movements of the jaw in mastication tend to move the articulation forward on the roots of zygomatic arches and wear down the articular eminence. Also that the nature of the food influences the masticatory habits of the individual.

If we are correct in this conclusion, the shallow glenoid fossa can have no racial or phylogenetic value. At best, it might give a possible hint as to the masticatory habits of an individual.

Doubtless other considerations such as age, growth, and pathological conditions enter into this matter. I should also expect to find many other changes accompanying this variation.

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